

Review and Analysis of NCAP Data for Monitoring Cultural and Natural Resources in the Grand Canyon

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Abstract

The National Civil Applications Program (NCAP) combined with the commercially available sensor systems may offer an effective way of monitoring and cultural and natural resources in the Colorado River Ecosystem of the Grand Canyon. The NCAP resources are examined in this study to determine their applicability for mapping vegetation habitats changes and the development of bare-ground digital terrain elevation data.

Introduction

The mapping and monitoring of landscape and habitat change in the Colorado River Ecosystem of the Grand Canyon is highly dependent upon a continuous source of high-quality and high-resolution spatial data. Acquiring a continuous source of reliable data to aid in understanding, quantifying, and predicting how the Colorado River Ecosystem functions is vital to Grand Canyon Monitoring and Research Center (GCMRC) in maintaining a highly effective long-term monitoring program.

The data resources of the U.S. Geological Survey (USGS) National Civil Applications Program (NCAP) may supplement to existing civilian aerial and orbital sensor data for fast and continuous wide-area mapping and monitoring of landscape and habitat change, as well as fulfill archival responsibilities of GCMRC for maintaining detailed temporal landscape information over environmental monitoring sites in the Grand Canyon.

Image derived information was generated from NCAP data resources along with civil aerial and orbital sensor data using advanced image processing and photogrammetric techniques to output information of four GCMRC monitoring sites within the Colorado River Ecosystem. The assessment of NCAP data resources is comprised of two parts:

1. Review and analysis of NCAP data resources to determine how flexible spatial data collection assets may be applied to supplement and validate detailed site information regarding physical, biological, and human induced changes. Of particular interest was the role NCAP data could play in supplementing the

development of bare-ground digital terrain elevation data and mapping changes in vegetation habitats.

2. Review and analysis of NCAP resources to determine whether archival data can support mapping and monitoring long-term landscape changes along the Colorado River corridor.

The write-up of this report is confined to what can be released to the civil community. Therefore, a detailed explanation of the study is not possible. This report is for Federal users only and not for indiscriminant distribution. Before proceeding, some background information about the NCAP and the Civil Application Committee (CAC), and related Imagery Derived Products and Global Fiducials Program, will broaden an understanding of this report's findings. The background information is derived from the following CAC published bulletins released for public distribution:

CAC, The Civil Applications Committee, July 2001
CAC, Rapid Exploitation System, (no date shown)
CAC, Imagery Derived Products, July 2001
CAC, Global Fiducials Program, February 2002

National Civil Applications Program

The CAC is an interagency committee, established in 1975 by Presidential directive to oversee the Federal civilian use of classified remote sensing data (herein referred to as National Systems data). Civilian agencies use National Systems data in a broad range of mapping, science, and environmental applications essential to their missions. The CAC coordinates and approves the use of National Systems data exploitation and application resources and supports remote sensing research and development activities at selected federal facilities, such as the Advanced System Center (ASC) and the National Center Collateral Facility (NCCF) located at the USGS in Reston, Virginia. The use of National Systems data resources in addition to equipment and software are made available through the USGS National Civil Application Program or NCAP at the ASC and NCCF.

Civilian agencies can use National Systems data for a broad range of civil applications, including national resources management, global change research, environmental monitoring, and natural disasters detection and mitigation. An Imagery Derived Product (IDP) is any information or representations derived from National Systems data. IDPs from the National Systems data can be used by Federal civil agencies as a supplement to mission requirements, but not as a replacement of conventional data sources.

A Federal civilian agency may request the declassification of an IDP when it is important to release or disclose the information to the civilian community or to an individual without a proper security clearance. There are few exceptions to the rule. One exception to the declassification process is made in the revision of cartographic products that are part of a standard mapping program of a Federal civil agency such as the USGS (e.g., digital line graphs and topographic maps). Such cartographic products are not considered

as IDPs and to not require specific use and technique approvals before they can be distributed to the public. Once an IDP has been declassified, it must be used in accordance with approval and policy guidelines. These guidelines specify what by-products can be generated, the techniques that must be used, the user application, and to whom they can be released to or disclosed.

The Global Fiducials Program brings together the data collection capabilities of National Systems and the data needs of environmental scientists through the USGS NCAP. Fiducials sites are defined as significant environmental sites for long-term monitoring of natural and anthropogenic processes so scientist can better understand the cause and effect of any changes. These sites are associated with five topical areas: ocean processes, ice and snow dynamics in Polar Regions, atmospheric processes, land use/land cover, and geologic processes. The Global Fiducials Library (GFL), which provides a centralized archive of the fiducials imagery and access to authorized users, is housed in the USGS ASC in Reston, VA.

The NCAP data exploitation system applied in this project is the Rapid Exploitation System (REx), which made use of National Systems data in combination with other data sources. The system is composed of the latest commercial and government off-the-shelf software and hardware.

Project Test Area

The regional location of the project area is in the southernmost part of Glen Canyon and the northern most part of the Grand Canyon segment of the Colorado Plateau and canyon lands of Arizona formed by the Colorado River (fig. 1). The marked change in relief in this area provides an excellent test of the National Systems data for supporting landscape change studies along the Colorado River corridor. GCMRC environmental monitoring sites 1 through 4 were selected for this test project.

Surveyed Reference Points

To know the accurate grid coordinate of any checkpoint in the project area, the U.S. Geological Survey (USGS) conducted static surveys in September 2001 (Sanchez, 2002) and July 2002. The selected photo-identifiable ground control points were occupied for over 30 minutes at 5-second and 1-second intervals using Ashtech Z-12 receivers. Simultaneous collection from the Flagstaff (FST1) and Las Vegas (LVWD) Continuous Operating Reference Station (CORS) at 5-second and 1-second intervals, respectively, provided the RINEX files (range and carrier phase or binary measurements, predicted orbital coordinates or ephemeris data, and site information files) used in the post processing with Ashtech Solutions version 2.5.

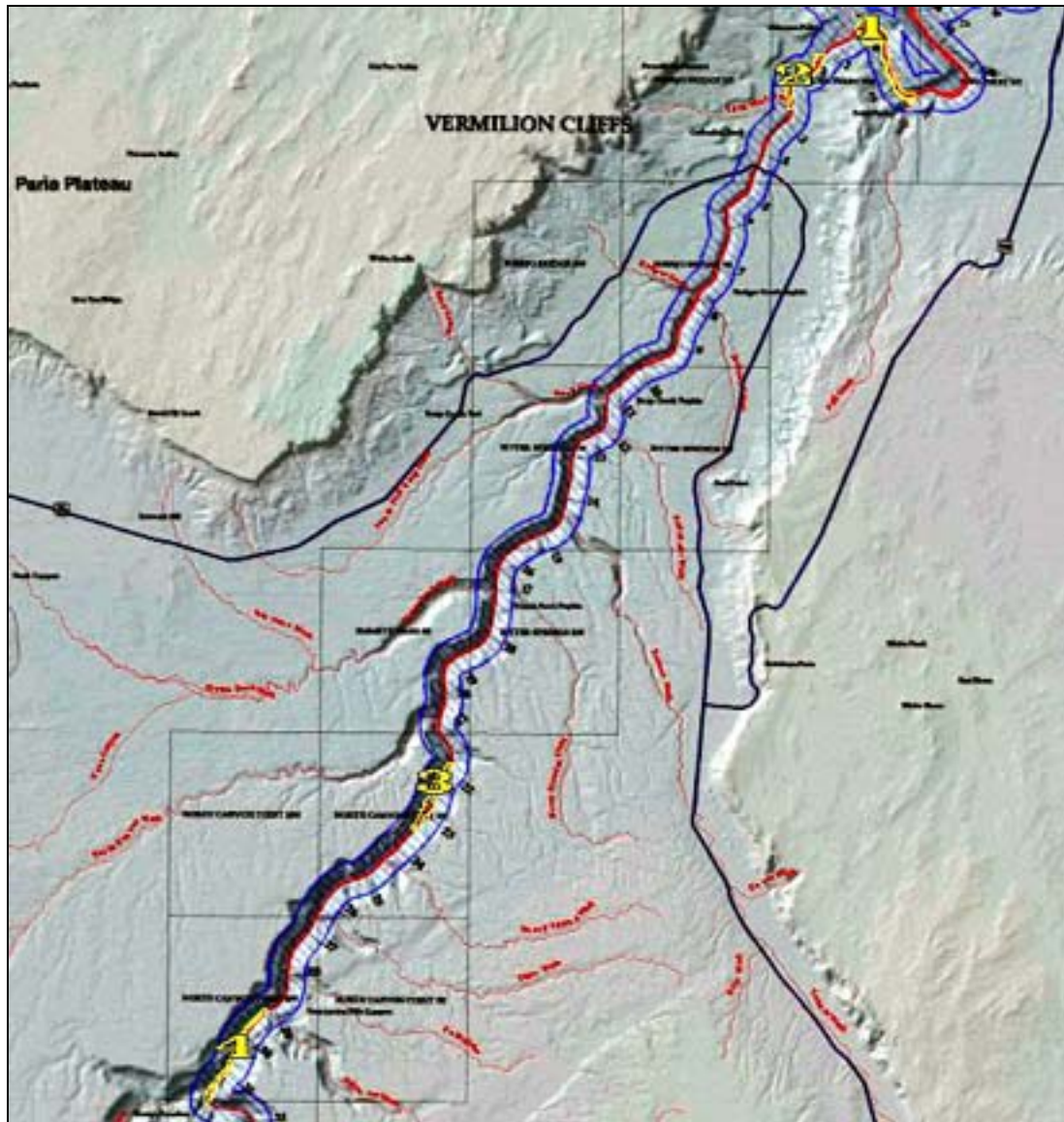


Figure 1. Regional location of selected GCMRC monitoring sites 1 through 4. Sites 1 and 2 are situated near Lees Ferry, Arizona.

Review and Analysis

Image derived products in the form of orthoimage mosaics and elevation models were generated of the four GCMRC sites. A review and analysis of the IDPs were conducted by selecting particular land-cover features along the river corridor (e.g., vegetation and sand bars). A comparison of the land-cover features was made between orthoimages derived from existing civilian sensor and National System data. The results varied from negligible to moderate differences in informational content and interpretability.

However, neither orthoimage product provided sufficient detail to meet GCMRC ground sample distance requirements. Absolute orientation of photo-identifiable feature was

examined using the horizontal and vertical coordinates in the stereoimage and the surveyed reference points. Differences between feature positions and corresponding surveyed reference points were measured on the digital photogrammetric workstation. The measured values in the stereoimage were roughly the same as to the ground-level positions of the surveyed reference points.

Conclusions

The findings of this study show that the spatial data collection assets of the NCAP may not meet the stringent requirements of GCMRC for mapping detailed changes in vegetation habitats and developing bare-ground digital terrain elevation data. Achieving those stringent requirements may have to come from low-altitude aerial photography and Lidar. However, this study does demonstrate the prospects of NCAP resources for long-term archiving and environmental monitoring. The potential benefits of adding National Systems data to the GCMRC program are far reaching, they include continuous year around coverage plus the added option of access to the Global Fiducials Library (GFL). The GFL's fiducial imagery can be access remotely by authorized scientist by means of an intuitive Web-like interface. Making a wide array of NCAP resources data through the GFL increases the opportunity for GCMRC management and scientist to make better-informed decisions.

Recommendations

Although, the results of this study did not meet large-scale mapping requirements of the GCMRC, the National Civil Application Program can provide valuable data resources for archiving and long term environmental monitoring. Further research is recommended for examining optimum levels of NCAP data resources to meet GCMRC user and accuracy requirements of more detailed topographic mapping and elevation data. It is important to keep in mind, however, the restrictions of National Systems data, and to balance the criteria for its use against practical considerations of doing long-term environmental studies in the Grand Canyon. For example, the need for a scientist with a minimum of a secret level clearance and the IDP limits on publications and distribution are present deterrents to applying National Systems data in the GCMRC program. However, the low cost of data acquisition and accessibility to REx hardware and software should compensate for some of these barriers.

In consideration of the above, we recommend the GCMRC make use of the National Civil Application Program in conjunction with the Global Fiducials Program for the archiving and long-term monitoring of the Colorado River Ecosystem so scientist can better study and understand the cause and effect of change over time.

Acknowledgment

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